Amendments to the Specification

Please amend the paragraph beginning at page 1, line 6, as follows:

The present invention relates to rendering devices and, more specifically, to a rendering device which can be incorporated in a drive assistant device. In more detail, the rendering device generates a drive assistant image of an area around a vehicle based on images captured by image capture devices securely placed in the vehicle.

Please amend the paragraph beginning at page 1, line 21, as follows:

The image capture devices 1001 to 1008 are directed in each different direction to cover the entire area around the vehicle *Vur*, and are responsible for ~~have charge of~~ image capturing. The resulting images are referred to as captured images S101 to S108, which are stored in the image memories 1009 to 1016, respectively. From several specific captured images stored in any predetermined image memory among those 1009 to 1016, the image processing part 1017 partially cuts out any required part. The parts are stitched together to have a single surrounding image S200 (see FIG. 19). The surrounding image S200 is then displayed on the display device 1018.

Please amend the paragraph beginning at page 2, line 7, as follows:

Here, FIG. 19 shows an example of the surrounding image S200 generated by the image processing part 1017 in the above manner. In FIG. 19, the surrounding image S200 is composed of partial images S106' to S108', which are respectively cut out from the captured images S106 to S108. The partial image S108' occupies a left-side region R2001 ~~S2001~~ of the surrounding image S200. The partial images S107' and S106' occupy, respectively, a center region R2002 ~~S2002~~ and a right-side region R2003 ~~S2003~~ of the surrounding image S200. Here, for convenience, a boundary between the left-side region R2001 and the center region R2002 is referred to as a seam boundary B2001, which is denoted by a dotted line in FIG. 19.

Please amend the paragraph beginning at page 2, line 19, as follows:

As another example of the conventional drive assistant device, there is a device for monitoring a surrounding area of a vehicle disclosed in International Publication WO00-07373. The monitoring device carries a plurality of image capture devices, which are responsible for image capturing ~~take charge~~ of each different region ~~for image capturing~~ and cover the entire region around the vehicle. The resulting images captured by those image capture devices are now referred to as captured images, and each show the region around the vehicle for which it is responsible ~~in charge~~.

Please amend the paragraph beginning at page 4, line 6, as follows:

The problem unsolved by the above-mentioned monitoring device is ~~of~~ not displaying an ~~the~~ image of an area that correctly resembles the area ~~as it should be~~. This problem is evident especially on the surrounding image wherein objects displayed in the image do not correctly resemble corresponding objects in the surrounding area ~~may not look as they should be~~. More specifically, as shown in FIG. 20A, presumably, placed on a road surface Frd is an object B, a cross section of which is reverse "L" shaped. In the above viewpoint conversion processing, as shown in FIG. 20B, the object B is viewed from viewpoints of image capture devices 2001 and 2002, and projected onto the road surface Frd therefrom. As a result, virtual objects B' and B" are obtained. Therefore, the spatial data resultantly generated from the captured image derived by the image capture device 2001 includes the virtual object B' as the object B, while the spatial data from the captured image 2002 includes the virtual object B".

Please amend the paragraph beginning at page 4, line 20, as follows:

By utilizing such two spatial data, the monitoring device generates one surrounding image. The issue here is, since the two spatial data include the virtual objects B' and B" each have different shapc, the monitoring device problematically cannot correctly render the object B, and the resulting object B is not correctly displayed ~~does not look as it should~~. As a result, the surrounding image generated by such monitoring device causes the driver to feel strange.

Please amend the paragraph beginning at page 5, line 10, as follows:

An aspect of the present invention is directed to a rendering device for generating a drive assistant image of around a vehicle for drive assistance. The vehicle includes a <u>steering</u> ~~rudder~~ angle sensor for detecting a <u>steering</u> ~~rudder~~ angle of the vehicle, and a plurality of image capture devices each for image capturing an area around the vehicle. Here, the images captured thereby include an overlapped region. The above rendering device comprises an image receiving part for receiving the images captured by each of the image capture devices; a <u>steering</u> ~~rudder~~ angle receiving part for receiving the <u>steering</u> ~~rudder~~ angle detected by the <u>steering</u> ~~rudder~~ angle sensor; and an image processing part for performing pixel selection from the captured images received by the image receiving part according to the <u>steering</u> ~~rudder~~ angle received by the <u>steering</u> ~~rudder~~ angle receiving part, and based on a result of the pixel selection, generating the drive assistant image.

Please amend the paragraph beginning at page 8, line 6, as follows:

FIG. 1 is a block diagram showing the hardware structure of a drive assistant device Uast1 incorporating a rendering device Urnd1 according to an embodiment of the present invention. In FIG. 1, the drive assistant device Uast1 is mounted in a vehicle Vur (see FIG. 2), and includes two image capture devices 1 and 2, a <u>steering</u> ~~rudder~~ angle sensor 3, a display device 4, and the rendering device Urnd1.

Please amend the paragraph beginning at page 8, line 13, as follows:

Here, FIG. 2 shows a top view of the vehicle Vur for illustrating a longitudinal median plane Flm and a lateral datum plane Ftr to be mentioned below. In FIG. 2, the longitudinal median plane Flm is a vertical plane passing through both a midpoint of a line segment Lfrt between rotation centers of the front wheels Wfrt1 and Wfrt2 of the vehicle Vur, and another midpoint of a line segment Lrr between rotation centers of the rear wheels Wrr1 and Wrr2. The lateral datum plane Ftr is also a vertical plane orthogonal, at least, to the longitudinal median plane Flm, and traversing the vehicle Vur. In the present embodiment, for convenience, the lateral datum plane Ftr presumably passes through two door mirrors Mdr1 and Mdr2.

Please amend the paragraph beginning at page 13, line 2, as follows:

As will be described later, the drive assistant device Uast1 generates a drive assistant image Sast (see FIG. 10) showing a rendering region Rrnd viewed from above. Here, in FIG. 8, the rendering region Rrnd is a region on the road surface Frd enclosed by the longitudinal median plane Flm, the lateral datum plane Ftr, and two sides of L1st and L2nd. The side L1st is

orthogonal to the lateral datum plane Ftr, and parallel to the longitudinal median plane Flm. The side L1st is away from the longitudinal median plane Flm by a predetermined space Δ<u>d</u>3. The side L2nd is parallel to the lateral datum plane Ftr, and orthogonal to the longitudinal median plane Flm. The side L2nd is away from the lateral datum plane Ftr by a predetermined space Δd4. Here, the spaces Δd3 and Δd4 are arbitrarily set depending on the design specifications of the drive assistant device Uast1, for example, 4m and 7m, respectively. With such spaces Δd3 and Δd4, the rendering region Rrnd partially includes the non-overlapped regions Rn1 and Rn2 as well as the overlapped region Rr1.

Please amend the paragraph beginning at page 13, line 27, as follows:

In FIG. 1, the <u>steering</u> ~~rudder~~ angle sensor 3 detects a <u>steering</u> ~~rudder~~ angle ρ of the steering wheel of the vehicle Vur. The detected <u>steering</u> ~~rudder~~ angle ρ is transmitted to a processor <u>7</u> ~~1~~. The <u>steering</u> ~~rudder~~ angle ρ indicates at what angle the steering wheel is turned with respect to the initial position. The steering wheel is considered in the initial position, preferably, when not turned, that is, when the vehicle Vur is in the straight-ahead position. In this embodiment, the <u>steering</u> ~~rudder~~ angle ρ is positive when the steering wheel is turned left, that is, when the vehicle Vur moves backward and rotates clockwise. Conversely, when the steering wheel is turned right, the <u>steering</u> ~~rudder~~ angle ρ is negative. This will be mentioned in the last of the present embodiment.

Please amend the paragraph beginning at page 14, line 23, as follows:

Further, the image buffers IBcpt1 and IBcpt2 are <u>each</u> assigned <u>to</u> ~~each~~ different ID number. In the present embodiment, the image buffer IBcpt1 is assigned #1, and the image buffer IBcpt2 #2, for example. As the image buffers IBcpt1 and IBcpt2 are allocated to the image capture devices 1 and 2, respectively, the ID numbers #1 and #2 also specify the image capture devices 1 and 2.

Please amend the paragraph beginning at page 15, line 5, as follows:

The drive assistant image Sast also includes, preferably, an estimated trajectory Tvhc for a left-rear wheel of the vehicle Vur (see FIG. 10). Here, the estimated trajectory Tvhc is derived based on the <u>steering</u> ~~rudder~~ angle ρ detected by the <u>steering</u> ~~rudder~~ angle sensor 3 under a technique typified by Ackermann's model. The estimated trajectory Tvhc is to be traced by the

left-rear wheel of the vehicle Vur on condition that the driver keeps the steering wheel at the currently derived steering ~~rudder~~ angle ρ. With the estimated trajectory Tvhc included in the drive assistant image Sast, the driver can easily judge whether the left-rear part of the vehicle Vur is likely to hit any obstacle in the close range.

Please amend the paragraph beginning at page 17, line 22, as follows:

As shown in FIG. 13, the mapping table Tmp includes (Nu × Nv) unit records Rn1, and show the correspondence between the pixels Pst in the drive assistant image Sast and the pixels Pcpt1 and/or Pcpt2 in the captured images Scpt1 and/or Scpt2. The unit records Rnt are each uniquely assigned to each of the pixels Pst in the drive assistant image Sast, and composed of a record type Trcd, the coordinate values (ub, vb) in the second UV coordinate system, the ID number, the coordinate values (ua, va) in the first UV coordinate system, a steering ~~rudder~~ angle range Rrng, and a blending ratio Rbrd.

Please amend the paragraph beginning at page 21, line 2, as follows:

As described above, in the unit record Rnt assigned to the pixel Pst belonging to the overlapped region Rr2, the record type Trcd indicates "2". In FIG. 13, to only those record units Rnt showing "2" in their record types Trcd, the steering ~~rudder~~ angle range Rrng is written. Specifically, every ID number accompanies two ranges of Rrng1 and Rrng2. The range Rrng1 is $0 <= \rho <= \rho th$, and the range Rrng2 is $\rho > \rho th$. Here, ρth denotes a threshold value, which is determined in the following manner and not equal among the unit records Rnt.

Please amend the paragraph beginning at page 21, line 11, as follows:

Here, the above-described estimated trajectory Tvhc can be derived in advance under the technique typified by the well-known Ackermann's model, and determined based on the steering ~~rudder~~ angle ρ. Such estimated trajectory Tvhc is represented in the world coordinate which defines the actual space. Therefore, by converting the trajectory Tvhc through the coordinate conversion processing into the one representable in the second UV coordinate system, the position for rendering the estimated trajectory Tvhc in the drive assistant image Sast can be known in advance. Assuming that the steering ~~rudder~~ angle ρ is increased from 0 degree by Δρ degrees (Δρ has a positive value), as shown in FIG. 15A, several estimated trajectories Tvhc1, Tvhc2, ... (shown are two) are represented in the second UV coordinate system. Here, the value Δρ is determined based on the design specifications of the drive assistant device Uast1, and the smaller would be the more preferable.

Please amend the paragraph beginning at page 22, line 2, as follows:

In FIG. 15A, the estimated trajectory Tvhc1 is the one derived when the steering ~~rudder~~ angle ρ is Δρ, and the estimated trajectory Tvhc2 when 2 ×Δρ. As shown in FIG. 15B, when the steering ~~rudder~~ angle ρ is Δρ, formed in the rendering region Rrnd is a partial rendering region PRrnd1 enclosed by an outline Lout of the rendering region Rrnd, the longitudinal median plane Flm, and the estimated trajectory Tvhc1. Here, the outline Lout is defined by the longitudinal median plane Flm, the lateral datum plane Ftr, and the sides L1st and L2nd shown in FIG. 8. When the steering ~~rudder~~ angle ρ is 2 × Δρ, formed in the rendering region Rrnd is a partial rendering region PRrnd2 enclosed by the outline Lout, and the estimated trajectories Tvhc1 and Tvhc2 as shown in FIG. 15C. Here, when the steering ~~rudder~~ angle ρ is j × Δρ, a partial rendering region PRrndj is formed similarly to the partial rendering region PRrnd2. Here, j is a natural number being 3 or larger.

Please amend the paragraph beginning at page 23, line 23, as follows:

For example, as shown in FIG. 13, the value of the pixel Pst at the coordinates (501, 109) is calculated by multiplying the blending ratio Rbrd of 1 by the value of the pixel Pcpt2 at the coordinates (551, 303) in the captured image Scpt2. As to the pixel Pst at the coordinates (324, 831) when the steering ~~rudder~~ angle ρ is in the range Rrng1, its value is calculated by adding two resulting values obtained by multiplying the blending ratio Rbrd1 of 0 by the value of the pixel Pcpt1 at the coordinates (1011, 538) in the captured image Scpt1; and multiplying the blending ratio Rbrd3 of 1 by the value of the pixel Pcpt2 at the coordinates (668, 629) in the captured image Scpt2. If the steering ~~rudder~~ angle ρ is in the range Rrng2, multiply the blending ratio Rbrd2 of 1 by the value of the pixel Pcpt2 at the coordinates (1011, 538) in the captured image Scpt1; and multiply the blending ratio Rbrd4 of 0 by the value of the pixel Pcpt2 at the coordinates (668, 629) in the captured image Scpt2. The resulting two values are then added to each other.

Please amend the paragraph beginning at page 25, line 3, as follows:

Described next is the operation of the above drive assistant device Uast1. When the driver wants assistance by the drive assistant device Uast1, for example, to check in what state the left-rear area of the vehicle Vur is, the CPU 7 starts executing the program PG1. Here, FIG. 16 is a flowchart showing the processing procedure in the CPU 7 written in the program PG1.

The CPU 7 first reads the vehicle image Svhc, and the mapping table Tmp from the ROM 8 to the RAM 9 (step S1). As storing the mapping table Tmp and the vehicle image Svhc, the RAM 9 exemplarily works as a table storing part and an image storing part ~~in Claims~~.

Please amend the paragraph beginning at page 25, line 13 as follows:

Then, the CPU 7 generates an image capturing instruction Icpt, and transmits it to the image capture devices 1 and 2 (step S2). The image capturing instruction Icpt is a signal instructing the image capture devices 1 and 2 for image capturing. In response to the capturing instruction Icpt, the image capture devices 1 and 2 capture the above-described captured images Scpt1 and Scpt2, and store those images in the image buffers IBcpt1 and IBcpt2, respectively (step S3). As storing the captured images Scpt1 and Scpt2 in step S3, the CPU 7 exemplarily works as an image receiving part ~~in Claims~~.

Please amend the paragraph beginning at page 25, line 23, as follows:

The CPU 7 then generates a detection instruction Idtc, and transmits it to the steering ~~rudder~~ angle sensor 3 (step S4). The detection instruction Idtc is a signal instructing the steering ~~rudder~~ angle sensor 3 to detect the steering ~~rudder~~ angle ρ. In response to the detection instruction Idtc, the steering ~~rudder~~ angle sensor 3 detects the steering ~~rudder~~ angle ρ, and stores it in the RAM 9 (step S5). As receiving the steering ~~rudder~~ angle ρ in step S5, the CPU 7 exemplarily works as a steering ~~rudder~~ angle receiving part ~~in Claims~~.

Please amend the paragraph beginning at page 26, line 6 as follows:

The CPU 7 then executes image processing according to the mapping table Tmp on the RAM 9, and generates a drive assistant image Sast from the captured images Scpt1 and Scpt2 in the image buffers IBcpt1 and IBcpt2 (step S6). In step S6, the CPU 7 exemplarily works as an image processing part ~~in Claims~~.

Please amend the paragraph beginning at page 26, line 11, as follows:

More specifically, the CPU 7 selects, based on the steering ~~rudder~~ angle ρ detected in step S4, several pixels Pcpt1 and Pcpt2 from the captured images Scpt1 and Scpt2 according to the mapping table Tmp. Based on those selected, the CPU 7 then determines a value for each of the pixels Pst in the drive assistant image Sast. Here, refer to FIG. 17 for a flowchart showing

the detailed procedure in step S6. In FIG. 17, the CPU 7 selects one unit record Rnt from the mapping table Tmp (step S21), and extracts every combination of the ID number and the coordinate values (ua, va) therefrom (step S22). Then, from the image buffers IBcpt1 and/or IBcpt2 specified by the extracted ID number(s), the CPU 7 takes out value of the pixel Pcpt1 and/or Pcpt2 specified by the extracted coordinate values (ua, va) (step S23).

Please amend the paragraph beginning at page 28, line 13, as follows:

In step S25, if the record type Trcd is determined as showing "2", the CPU 7 extracts the range Rrng1 from the unit record Rnt selected in step S21 (step S28). Then, the CPU 7 determines whether the steering ~~rudder~~ angle ρ detected in step S5 is in the range Rrng1 extracted in step S28 (step S29). If determined Yes, the CPU 7 then extracts the blending ratios Rbrd1 and Rbrd3 assigned to the range Rrng1 (step S210).

Please amend the paragraph beginning at page 28, line 8, as follows:

For example, if selected in step S21 is the unit record Rnt wherein the coordinate values (ub, vb) are (324, 831), step S28 is carried out. Here, assuming that the steering ~~rudder~~ angle ρ detected in step S5 satisfies $0 <= \rho <= \Delta \rho$, extracted in step S210 are 0 and 1 as the blending ratios Rbrd1 and Rbrd3. Then in step S211, a value obtained by multiplying the blending ratio Rbrd1 of 0 by the value of the pixel Pcpt1 at the coordinates values (1011, 538) and a value obtained by multiplying the blending ratio Rbrd3 of 1 by the value of the pixel Pcpt2 at the coordinates values (668, 629) are added together. The resulting value is the value of the pixel Pst at the coordinates value (324, 831), and stored in the frame memory FMast in step S27.

Please amend the paragraph beginning at page 29, line 20, as follows:

As another example, if selected in step S21 is the unit record Rnt wherein the coordinate values (ub, vb) are (971, 1043), step S28 is also carried out. Here, assuming that the steering ~~rudder~~ angle ρ detected in step S5 satisfies $0 <= \rho <= \Delta\rho$, extracted in step S210 are 0 and 1 as the blending ratios Rbrd1 and Rbrd3. Then in step S211, a value obtained by multiplying the blending ratio Rbrd1 of 0 by the value of the pixel Pcpt1 at the coordinates values (1189, 999) and a value obtained by multiplying the blending ratio Rbrd3 of 1 by the value of the pixel Pcpt2

at the coordinates values (1135, 798) are added together. The resulting value is the value of the pixel Pst at the coordinates value (971, 1043), and stored in the frame memory FMast in step S27.

Please amend the paragraph beginning at page 30, line 7, as follows:

In step S29, if the steering ~~rudder~~ angle ρ is determined as not in the range Rrng1, the CPU 7 extracts the blending ratios Rbrd2 and Rbrd4 assigned to the Rrng2 from the unit record Rnt selected in step S21 (step S212). As described above by referring to FIG. 14, the blending ratios Rbrd2 and Rbrd4 are multiplied to the pixels Pcpt1 and Pcpt2 when the steering ~~rudder~~ angle ρ is in the range Rrng2. After step S212 is through, the CPU 7 adds a value obtained by multiplying the blending ratio Rbrd2 by the value of the pixel Pcpt1 and a value obtained by multiplying the blending ratio Rbrd4 by the value of the pixel Pcpt2 together. The resulting value is determined as the value of the pixel Pst at the coordinates value (ub, vb) specified by the unit record Rnt selected in step S21 (step S213). The procedure then goes to step S27, and the CPU 7 stores thus determined value of the pixel Pst in the frame memory FMast (see FIG. 9).

Please amend the paragraph beginning at page 30, line 22, as follows:

The CPU 7 repeats the procedure in steps S21 to S213 until every unit record Rnt in the mapping table Tmp is selected (step S214). After the processing is through, the drive assistant image Sast (see FIG. 10) is generated for one frame. In the processing, assuming that the steering ~~rudder~~ angle ρ stored in step S4 is Δρ, the value of the pixel Pst belonging to the partial rendering region PRrnd1 in the drive assistant image Sast is determined only by the captured image Scpt1. Other than the partial rendering region PRrnd1, the value of the pixel Pst is determined only by the captured image Scpt2. In other words, in the drive assistant image Sast, the value of the pixel Pst is determined based on both the captured images Scpt1 and Scpt2 with reference to the estimated trajectory Tvhc1. Therefore, the drive assistant image Sast has such characteristic as follows. Generally, the driver of the vehicle Vur avoids obstacles blocking his/her way, and thus the obstacle is hardly located in the close range to the vehicle Vur but often a little away therefrom. Therefore, if the CPU 7 determines the value of the pixel Pst based on the captured images Scpt1 and Scpt2 depending on whether the pixel Pst is in the partial

rendering region PRrnd1, there is a little possibility of the obstacle lying on the estimated trajectory Tvhc. Accordingly, the drive assistant image Sast hardly bears such problem of the conventional drive assistant devices. As such, the problem unsolved by the conventional drive assistant devices (those disclosed in Japanese Patent Laid-Open Publication No. 11-78692 (1999-78692) and in International Publication WO00-07373) are now clearly solved, and thus the drive assistant image Sast provided by the rendering device Urnd1 barely causing the driver to feel strange.

Please amend the paragraph beginning at page 32, line 1, as follows:

Once the CPU 7 determines that every unit record Rnt is selected in step S214, this is the end of the processing in FIG. 17, and the procedure goes to step S7 in FIG. 16. Here, due to the mounting positions of the image capture devices 1 and 2, the vehicle Vur hardly appears in the captured images Scpt1 and Scpt2. This is the reason why the drive assistant image Sast generated in step S6 does not include the vehicle Vur. After the procedure completing the processing in FIG. 17, the CPU 7 thus renders the vehicle image Svhc on the RAM 9 onto the overlaying position Pvy on the drive assistant image Sast (step S7). In step S7, the CPU 7 exemplarily works as a vehicle rendering part ~~in Claims~~.

Please amend the paragraph beginning at page 32, line 13, as follows:

Then, the CPU 7 derives the above-mentioned estimated trajectory Tvhc based on the rudder angle ρ stored in step S7 under the technique typified by the Ackermann's model (step S8). The CPU 7 then renders thus derived estimated trajectory Tvhc on the drive assistant image Sast processed in step S7 (step S9). In steps S8 and S9, the CPU 7 exemplarily works as a trajectory deriving part ~~in Claims~~. Assuming here that the <u>steering</u> ~~rudder~~ angle ρ stored in step S4 is Δρ, rendered is such estimated trajectory Tvhc1 as described referring to FIG. 15A, whereby the resulting drive assistant image Sast looks as the one shown in FIG. 10.

Please amend the paragraph beginning at page 33, line 9, as follows:

At this point in time, assume that the driver turns the steering wheel and the steering ~~rudder~~ angle ρ is now 2 × Δρ. Under this assumption, with the above-described processing in FIG. 16 carried out, the value of the pixel Pst belonging to the partial rendering regions PRrnd1 and PRrnd2 in the drive assistant image Sast is determined only by the captured image Scpt1. Other than the partial rendering regions PRrnd1 and PRrnd2, the value of the pixel Pst is determined only by the captured image Scpt2. In other words, in the drive assistant image Sast, the value of the pixel Pst is determined based on both the captured images Scpt1 and Scpt2 with reference to the estimated trajectory Tvhc2. For example, as shown in FIG. 13, the value of the pixel Pst at the coordinates (501, 109) is determined as being the value of the pixel Pcpt2 at the coordinates (551, 303) regardless of the steering ~~rudder~~ angle ρ.

Please amend the paragraph beginning at page 33, line 23 as follows:

As to the pixel Pst at the coordinates (324, 831), if the steering ~~rudder~~ angle ρ is 2 × Δρ, the range Rrng1 is not applicable. Thus, step S212 is carried out. In such case, the value of the pixel Pst is calculated by adding two resulting values obtained by multiplying the blending ratio Rbrd2 of 1 by the value of the pixel Pcpt1 at the coordinates (1011, 538); and multiplying the blending ratio Rbrd4 of 0 by the value of the pixel Pcpt2 at the coordinates (668, 629).

Please amend the paragraph beginning at page 34, line 6 as follows:

As to the pixel Pst at the coordinates (971, 1043), if the steering ~~rudder~~ angle ρ is 2 × Δρ, the range Rrng1 is still applicable. Thus, step S26 is carried out.